ON DYNAMIC INFLUENCES IN EVOLUTION.

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It is generally admitted that in the doctrine of Natural Selection we have a theory which accounts for the perpetuation of favorable variations in organic beings and their progeny, and for the elimination in the long run of those which vary in unfavorable directions. It is equally admitted that the origin of variation is not accounted for by this theory. In order to round out our conception of the mode of evolution of the organic universe it is necessary that this deficiency should be supplied, and that to it should be added some conception of the mode by which variation is sustained in any given direction until it has reached a point where its usefulness is sufficiently marked to enable the selective process to operate. Besides this it is hardly doubtful that there are many characters developed in organisms, especially those of the lower rank, in which selection of any sort is but little concerned.

It is not necessary to recapitulate the names of those who have turned to the relations between the organism and its environment as the only nidus of the influences sought. Such an enumeration would comprise nearly all American biologists of prominence and many foreign naturalists.

On the other side of the Atlantic a small but not unimportant number of biologists, of whom Weismann and Lankester may be taken as spokesmen, have recently endeavored to show

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that the current of hypothesis most favored in America, though not confined to our naturalists, is running in a wrong direction, although they do not seem to have any satisfactory alternative to offer.

For convenience in discussion those who accept the ideas referred to, in greater or less degree, may be termed Dynamic Evolutionists. Their position has been very fairly and temperately stated by Osborne in his article on the paleontological evidence of the transmission of acquired characters.* Without attempting to speak for others I have felt that a statement of the position to which I have been led by my own studies might not be without use in the present status of the question.

In the first place, in opposition to the notion that characters acquired in other than the embryonic or larval condition are not transmitted to the progeny ;—I maintain that a direct or indirect transmission of acquired characters is absolutely essential to any theory of evolution and that, speaking broadly, the whole system of Darwinism must stand or fall with this hypothesis. It is as axiomatic as the "survival of the fittest" itself.

It therefore becomes necessary to define what is meant by "acquired characters" and their "transmission."

The environment stands in a relation to the individual such as the hammer and anvil bear to the blacksmith's hot iron. The organism suffers during its entire existence a continuous series of mechanical impacts, none the less real because invisible, or disguised by the fact that some of them are precipitated by voluntary effort of the individual itself. So far as re-

*Nature Jan. 9, 1890, p. 227; Science, 1890, p. 110. The name Neo-Lamarckian is objectionable, as it tends to connect with the modern hypothesis the different and obsolete theory of the distinguished French naturalist.

sults are concerned, for the ground to strike the horse's hoof would be the same as for the horse to strike the ground with his hoof; direction and dynamic value of shock being assumed to be equal in the two cases. Since individual organisms usually appear free to wander about or remain quiescent, the idea that they are under constant stress does not ordinarily suggest itself. To this habit of superficial observation I ascribe the slowness with which the dynamic element in evolution has received recognition, though pointed out clearly so long ago, by Herbert Spencer.

That which distinguishes the organic individual from the inorganic fragment of matter is the complexity of its reäction to these impacts, which reäction we term physiological in contra-distinction to the simply mechanical, though both, at bottom are doubtless similar.

The characters which develop in an organism in response to these impacts are acquired, but that which is transmitted is a facility of response in the same line, which may, under favorable circumstances, lead to a similar response in the progeny, and, in the course of time with a continuation of similar impacts through successive generations, promote and establish the physiological habit which is the directive influence toward the regular development of the characters in question.

It is, I believe, generally admitted that such is the case in relation to mental stimuli and reäctions in man and some of the higher animals and that the growth of intellectual life in the human race depends upon it.

It is a matter of indifference, dynamically, whether the particular series of impacts concerned in developing a special physiological response is the result of conscious effort by the organism or not; but, as it is highly unlikely that any volun-

tary effort, no matter how seconded by habit, should be as constant and unceasing as the impacts due to ordinary mechanical forces, we should expect the responses due to conscious effort to be feeble in intensity and numerically few in comparison with those arising from the dynamic forces undirected by consciousness.

The dynamics of the environment, so far as we are able to understand them, in their principal features must be remarkably constant. The weight and consistency of the water or air which forms the surrounding medium, the character of the supporting surface, the range of temperature, the supply of light, the friction of adjacent bodies, the attraction of gravitation, vary within comparatively narrow limits, when consistent with organic existence. We should therefore expect that their influence would on the whole be conservative and tend toward the preservation of the main characteristics of organisms once brought into substantial equilibrium with their surroundings.

On the other hand, owing to the very narrowness of the limits within which life is possible, the dynamic variations, within those limits, to which organic forms are subjected become relatively more important. It is probable that since the initiation of life upon the planet no two organisms have ever been subjected to exactly the same dynamic influences during their development. Differences of impact necessarily imply differences in response, hence a certain amount of variation is the inevitable result. It is absolutely impossible that any two individuals can be or ever have been strictly similar and the application of a conception of exact similarity to any two actual beings becomes more and more difficult as the complexity of their organization is increased.

The origin of variation therefore presents no difficulties;

rather the presence of two strictly similar beings, could it be shown, would border on the miraculous.

The question which demands an answer is, how are the small necessary and admitted differences stimulated to develop into the obvious differences which are recognized by systematic biologists?

To this I would answer that the reäctions of the organism against the physical forces and mechanical properties of its environment are abundantly sufficient, if we are granted a simple organism, with a tendency to grow, to begin with; time for the operation of the forces; and the principle of the survival of the fittest.

It is often assumed in discussing variation that the possibility of variation is equal in every direction. A consideration of the dynamic conditions of life show that this is not the case, or at least, if we grant its theoretic truth, in practice it never can be true. Under any conditions which would permit it, the resulting organic forms would all be sub-spherical, and would have to pass their existence in constant rotation.

The moment that any one of them came to rest it would begin to be subjected to unequal stresses relatively to its different parts. Light, gravity, friction, opportunities for nutrition, would be unequally distributed, with the result of forcing an unequal growth, development, and specialization of its regions. Inequality of form once established, if it were a moving organism, friction and resistence of the circumambient medium would confirm the inequality and put individuals of its kind at a disadvantage when they varied toward the original shape. Flexure of an elongated body would mechanically institute changes analogous to segmentation, as pointed out by Spencer. Any organic mass possessed of mechanical continuity must develop surface tension and initiate a superficial film.

The fact that these portions of matter are organic, in no respect releases them from the common servitude of matter to the laws of mechanics through the operation of physical forces.

If then development of structure is constrained to operate within a limited field, which can hardly be denied, all those calculations based upon the assumption that the field is unlimited fall to the ground and may be safely disregarded as irrelevant.

The operations of biologic selection may be divided into two categories, 1st. those in which fitness and unfitness are determined by the perfection in adjustment of the individual to the mechanics of the environment, which will include the great mass of the lower organisms; and 2nd., those in which intelligence becomes a factor. The latter will include all forms of sexual selection, mimicry, protective coloration, and every case in which discrimination on the part of pursuer or pursued may come into play. It is by no means necessary that the organism which becomes modified should possess even consciousness, but one of the two parties to the modification, at least, must possess intelligence of a certain grade. The mental qualities of the insect are necessary to the modification of the colors of the orchid, as far as they serve to attract its attention or direct its movements, while the modifications of the stigma or pollen mass to facilitate cross fertilization, fall into the other category.

While the operations of the first category must always have been active, and probably were not supplemented by those of the second category for an immense period of time, yet I believe the latter also to be very ancient. It is probable, however, that influences of the second category operate more rapidly and are productive of much greater diversity in devel-

opment than could ever have been expected from the unassisted working of the physical forces.

Passing from these general considerations to those of a more special character, the contention of Weismann that "not a single fact hitherto brought forward can be accepted as proof" of the transmission of acquired characters demands attention. This reminds one of the familiar statement of twenty years ago that the Darwinians had not brought forward a single instance of the conversion of one species into another species. If the Dynamic Evolutionist brings forward an hypothesis which explains the facts of nature without violence to sound reasoning, that hypothesis is entitled to respect and consideration until some better one is proposed or some vitiating error is detected in it. No one has yet "proved" that one species is developed out of another species in the sense in which Weismann uses the word proof in his criticism. But plenty of facts which support the hypothesis that acquired characters are transmitted in the sense hereinbefore explained have been accumulated, of which Osborne's paper, above cited, affords evidence in one direction. Can anyone believe that the permanent limb-callosities of the horse and deer, for instance, are selective developments of fortuitous larval corns? Our knowledge of the physiology of any animal, except too or three which have been domesticated for ages, and excepting man, is so contemptibly meagre that it cannot be quoted as evidence on either side.

The question has been much obscured by the attempt to quote the effect or non-effect of mutilations upon progeny, on one side or the other.

For the Dynamic hypothesis only those characters can be considered which arise from permanent physiological reactions due to the impact of external forces. Mutilations rarely fall

into this category and are essentially sporadic. In the case of circumcision, so often cited, they affect, at most, half the individuals of a race and only half of any one generation.

There is not a particle of reason to believe that the excision of a trifling scrap of cuticle from an infant would lead to any physiological reäction worthy of attention. One might with greater warrant seek such an effect in the growth of hair and of the nails in civilized races accustomed to trim them. Neither case has been shown to afford valuable evidence.

There is no reason to deny that a pathologic incident of sufficiently fundamental character may effect the progeny of an individual, but it is of no consequence to the Dynamic hypothesis whether it can be proven or not.

Experience shows that it is not single mutilation or loss of substance which results in permanent physiological reäctions so much as continued impacts which lead to locally increased nutrition or local anaemia.

The objection to reasoning drawn from pathologic cases is not that it is not or may not be true, but that the cause affects only individuals in trifling numbers.

The forces invoked by Dynamic hypothesis, on the other hand, affect every individual of a race and every generation as long as the environment continues unchanged. Sporadic modifications must always be finally swallowed up in the general average of the organic type, unless carefully selected by intelligent agencies. The steady pressure of telluric forces lets no individual escape.

On the coast of California the soft tertiary sandstones are drilled by several species of boring mollusks, *Pholas*, *Lithophagus* and *Petricola*. In the course of time the borers die and leave their closely fitting cells untenanted. Into these safe retreats the young of several non-boring bivalves are in the habit of retiring.

As they grow they become too large to escape by the hole through which they entered. Grow they must but the stone walls of their dwelling permit growth only in certain directions. The collector breaks the rock and finds *Kellia*, *Tapes* or *Rupellaria* with the outward conformation of the antecedent borer. Those which refused to conform, if any, have died. Here we have a case where characters have been assumed under an abnormal stress analogous to a pathologic or traumatic mutilation. The progeny of these nestlers would probably exhibit no traces of their parents' deformity. But the pressure of the physical forces on this progeny would be, though invisible, as constant and effective in its results as the rock seemed to be with the nestlers. These results in proportion to their harmony with the environment produce upon the observer the impression which is implied when he speaks of the appearance of such species as "normal."

In my paper on the hinge of Pelecypods and its development,* I have pointed out a number of the particular ways in which the dynamics of the environment may act on the characters of the hinge and shell of bivalve mollusks.

In a paper now in preparation for publication I have shown how the initiation and development of the columellar plaits in *Voluta*, *Mitra* and other Gastropods, is the necessary mechanical result of certain comparatively simple physical conditions; and that the variations and peculiarities connected with these plaits perfectly harmonize with the results which follow with inorganic material subjected to analogous stresses.

Attention once directed to this class of influences and their effects and it is certain facts will accumulate not less numerous

*Am. Journ. of Science, Dec., 1889, p. 445.

and convincing in their establishment of the theory than those which have been taken as "proof" of the survival of the fittest.

NOTE. Since this paper was delivered before the society the discussion of the subject has been continued in the pages of *Nature*. I have been interested to note that Prof. Lankester (in the issue for Mar. 6, 1890, page 414) like the skilled tactician he is, has begun building bridges in his rear which may serve as a means of retreat from his present untenable position. He now explains that by the "transmission of acquired characters" he means the obsolete theory of Lamarck in its purity, which, so far as I have followed the discussion, nobody has proposed to uphold. Why he has continued to oppose the Dynamical theory by arguments intended to demolish a totally different hypothesis, he does not explain.

Mr. Romanes has also pointed out that recent admissions of Dr. Weismann are fatal to the ingenious hypothesis and assumptions with which that gentleman's name has been chiefly connected (*Nature*, Mar. 13, 1890, p. 429.)

In fact these and other signs indicate that the most able of those who have through haste or conservatism been disposed to ignore dynamical influences in evolution, will before long join in the procession, and lend their undoubted abilities to the perfection and elaboration of the only theory yet propounded which fully and efficiently supplements that of Natural Selection and closes the too obvious gaps which have hitherto existed in the intellectual structure of the modern theory of organic evolution.